Please amend the Abstract of the Disclosure as follows and as provided on a separate sheet attached hereto:

ABSTRACT OF THE DISCLOSURE

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A fiber composite component has a piezoelectric actuator or sensor integrated therein. Electric feed lines for the actuator or sensor are constructed in the form of electrically insulated thin wires which exit the fiber composite almost perpendicularly to the laminate layers, so that the fibers of the fiber composite component are not severed by the leading-out of the feed lines, but are slightly pushed apart.

(Applicant's Remarks are set forth hereinbelow, starting on the following page.)

REMARKS

Entry of the amendments to the specification, claims and abstract before examination of the application is respectfully requested. These claims patentably define over the art of record.

If there are any questions regarding this Preliminary Amendment or this application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

It is respectfully requested that, if necessary to effect a timely response, this paper be considered as a Petition for an Extension of Time sufficient to effect a timely response and shortages in other fees, be charged, or any overpayment in fees be credited, to the Account of Crowell & Moring, LLP, Deposit Account No. 05-1323 (Docket #843/49885).

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE SPECIFICATION

Please amend the following paragraphs of the specification as follows:

[0003] In piezoelectric materials, such as quartz crystals or PZT-ceramics (PZT = lead - zirconate - titanate), an applied electric field results in elongations or contractions of the material. Piezoceramic actuators are therefore able to convert electric energy directly into mechanical energy and offer advantages, such as high actuating resolution, high actuating power and very short response times, while their size is small. This effect is [reversed] <u>reversible</u> in the case of piezoelectric materials; that is, a time-variable mechanical elongation of such ceramics causes , a charge displacement between the electrodes which can, in turn, be tapped as an electric sensor signal. In combination with suitable sensors and control, actuator systems can be implemented which can automatically adapt (that is, are adaptive) to changed operating conditions.

[0004] Piezoceramic actuators and sensors are typically constructed as stack actuators, elongators [and] <u>or</u> bending actuators. The former consist of stacks of thin piezoceramic disks which are elongated or shortened approximately linearly along the longitudinal stack axis under an exterior electric field. The two latter consist of thin ceramic plates which, as a rule, are flatly connected with a carrier structure and

elongate the latter while an electric voltage is impressed and generate an electric signal when the structure is elongated. In an asymmetrical integration into the carrier structure, or in the controlling of a bimorph in opposite directions (bimorph = actuator or sensor consisting of at least two separately bonded and mutually insulated piezoelectric wafers which are arranged in two or more planes in a parallel and congruent manner above one another), by means of the actuators, bending moments can therefore also be induced. When such elongation is blocked, elongators and bending elements can be electrically controlled to transmit forces to the corresponding structure and, to a certain degree, increase its stiffness.

[0011] This actuator type is permissible only for temperatures of up to maximally 100_C; at higher temperatures, parts of the plastic materials used for the encapsulating and gluing-together of the individual layers start to decompose; this generally leads to a massive delamination of the actuator, and to catastrophic destruction. However, modern [high-capacity] <u>high-performance</u> composite materials are generally manufactured at temperatures of up to 180°; sometimes, [a temperature adjustment (afterbaking)] <u>an additional cure cycle (post-cure)</u> of the components at still higher temperatures will be required.

[0012] The described tails of the QuickPack® actuators are incompatible with a structurally conformal integration in fiber composites, because guiding of the electric feed line

out of a fiber composite component requires severing the cover layers on the actuator. The latter is necessarily accompanied by an intolerable reduction of [the stability,] strength, destroying the advantage of a structural integration.

[0016] These and other objects and advantages are achieved by the fiber composite according to the invention, in which the piezoceramic sensor or actuator integrated therein has feed lines for the sensor or actuator in the form of electrically insulated thin wires which extend out of the fiber composite perpendicular to the laminate layers, so that the fibers are not severed by the leading-out of the feed lines, but are only slightly pushed apart. This arrangement achieves the integration of the actuator or sensor into the fiber composite structure without a significant reduction of the [stability] strength characteristics of the component.

[0025] As mentioned above, the tails of encapsulated piezoceramic actuators (such as QuickPack® actuators) are not compatible with a structurally conformal integration in fiber composites because the leading of such an electric feed line out of a fiber composite component requires severing the cover layers, necessarily resulting in an intolerable reduction of [the stability.] stength. The tail is therefore cut off close to the actuator and the copper strip conductors applied to the polyimide foils are partially ground, for example, by means of a fine diamond milling cutter. Electric connection can then be made via thin cables which are soldered onto the copper strip conductors by means of a suitable solder which must not

liquefy in the environmental conditions existing during the production. Care should be taken in this case that the soldering point does not thicken and that the entire connection area does not exceed the thickness of the actuator. When the cables (such as a copper . 0.2 mm or . 0.5 mm insulated wire) are selected, care should be taken, on the one hand, that they are sufficiently electrically insulated and, on the other hand, will withstand the environmental conditions during the production without damage and in a fully operable manner. Likewise, the line cross-section, corresponding to the later operating range of the actuator, must be selected such that no heating of the electric feed line, and thus no fault or even damage to the structure, can occur. Another advantage of the modification of the electric feed line, as described, is a significant simplification of the handling of the feed lines in further production processes, because, for example, their length, can be adjusted arbitrarily.

[0027] In the structural integration of the actuators into the fiber composite, generally a large number of different configurations are possible. Three specific configurations are illustrated as examples in Figure 2. In all three, the actuator A is integrated in the fiber composite component; that is, the actuator is covered on both sides by at least one layer of the laminate L. In the construction according to Figure 2.a, no laminate layers are severed for the integration of the actuator, which is placed between two adjoining layers of the laminate L. In the embodiment according to Figure 2.b,

recesses for the actuator A are provided in several laminate layers, while Figure 2.c is a mixed form of the two previously described embodiments according to Figures 2.a and 2.b. In Figure 2.c, individual layers are provided with recesses, whose entire thickness is, however, less than the height of the actuator A. The layers provided with the recesses are adjoined by layers without recesses. During the [baking] curing of the component, the resulting pockets H will be filled with resin.

[0029] By means of a template and a fine needle, penetration points for the electric feed lines are marked in the cover layers (layers above the actuator), to which the [tear-off woven] peel-ply has been applied on one side. This technique ensures that the reinforcing fibers of the structures are only pushed apart, and not severed, which finally has a considerable effect on the [stability] strength of the component. Subsequently, the electric feed lines are guided through the cover laminate and tightened, and the laminate is pressed together with the remaining component. In principle, several wires can also be led through a common opening. In all operating steps, particularly consolidation in a vacuum, a buckling of the cables is to be avoided.

[0030] A standard construction according to Figure 3 is used for the baking of the fiber composite component in the autoclave. The reference numbers indicate the following:

1 base plate

2 edge strip

3 [tear-off] Teflon [woven] peel-ply

4 metal pressure [sheet] plate

5 [separating foil] release film

6 sealing tape (mastic)

7 vacuum [foil] bag

8 [nonwoven] breather cloth

9 vacuum [connection piece] breach unit

10 fiber composite

[0031] Instead of a massive pressure [piece] plate (normally, polished aluminum plate with t $\geq$ 12 mm), a thin metal pressure [sheet] plate 4 is used, as separately illustrated in Figure 4. As a result of the correspondingly reduced stiffness, the slight thickening in this area, which is generally caused by the integration or application of the actuator, is taken into account; that is, pressing-out of the matrix in the corresponding section, when pressure is [admitted] applied in the autoclave, will be reduced, and the mechanical characteristics of the fiber composite are therefore only slightly influenced.

[0032] Aluminum sheets of a thickness of 2 mm were found to be suitable for use as metal pressure sheets. At the points at which the electric feed lines emerge from the component (in the described process, any site on the surface of the fiber composite component), bores are made in the metal sheets. The latter have a diameter d which, in the case of the utilized thickness of the metal pressure sheet, should be approximately

1 mm above the diameter of the used electric conductor. From the laminate side, these bores are counterbored a good 1 mm deep and are deburred. Finally, the metal pressure sheet is treated by means of conventional [separating] release agents. Instead of the above-mentioned bores, openings of any cross-section can be present in the metal pressure sheet, which are beveled on the laminate side.

[0034] When preparing the autoclave [construction,] setup, care should be taken that the wires are tightly guided through the metal pressure sheets and, during the [operation,] cure process, are not damaged or sheared off by the metal pressure sheet. As soon as the metal pressure sheet and the edge strips 2 are fixed, the bores, from which the wires are guided through the metal pressure sheet, are sealed off on both sides by means of several strips of sealing tape 6 and the wires are then loosely fixed on the metal sheet.

[0035] During the [baking] curing of the component, the pressure values and temperature values are particularly within the following ranges:

Pressure: 3 - 10 bar,

temperature: 120 - 220 _C.

[0036] The described process and resulting structure have the following advantages:

- Because the wires are guided out of the laminate perpendicularly to the surface, which can occur at any location because the wires can be continued without any significant disturbance of the laminate characteristics in the plane, the usually required edge trimming of the components is permitted. This was not possible in such a simple manner in the prior art solutions disclosed in the literature.

- The use of metal pressure sheets instead of massive pressure pieces largely maintains the characteristics of the fiber composite structure, so smoother geometrical transitions can be created in the component in the areas of the integrated actuators, while mechanical [tension peaks] <u>stress concentrations</u> are significantly reduced.

- By guiding the electrical feed lines through the metal pressure sheet precisely at the points at which they emerge from the laminate, the perfect surface quality of the component is completely maintained.

- Countersinking of the bores in the metal pressure sheet significantly reduces the danger of damage to or of shearing off the electric feed lines, and leads to higher permissible tolerances during the manufacturing.

- The use of sealing tape at the outlet points protects the electric feed lines on the metal sheet against (breaking-off) buckling.

- Since pressure is applied in the autoclave (generally 7 bar outside the autoclave construction) before the rise in temperature (generally 180_C) liquefies the matrix, a portion of the sealing tape applied around the bores is pressed through the gaps between the wire and the metal pressure sheet and completely fills the truncated cone formed by the countersinking of the metal sheet. (No air pockets are created in this case, because of the fact that the component inside the autoclave construction is simultaneously acted upon by the vacuum.)

[0037] This results in the following advantages:

- Excellent sealing-off of the bores; no resin outflow with the corresponding negative consequences on the mechanical characteristics of the component.

- Absolutely planar surface at the points of the exiting of the wire from the laminate by the isostatic pressure distribution already before the liquefaction of the matrix.

- Because the sealing tape is pressed in the gap between the metal pressure sheet and the wire, no

gluing-together of the metal pressure sheet and the wire can occur by the emerged matrix.

- The small gap between the metal pressure sheet and the wire minimizes the tensile or pushing force to be overcome for lifting-off the metal pressure sheets after the [baking] curing of the component, minimizing the danger that the wires are torn off. The metal pressure sheets can easily be detached from the component.

[0039] Detailed studies have demonstrated that the catastrophic destruction of the QuickPack® actuators in the case of the above-described processing according to the prior art is most probably caused by sublimation of the internal adhesive layers and partially sublimation of the thermoplastic spacers at temperatures above approximately 100°C., which cause large-surface delaminations in the actuator. Such destruction of encapsulated piezoceramic actuators can be prevented by an application of pressure applied simultaneously with the temperature load.

[0040] The [baking] cure cycle of some matrix systems includes a tempering process ([afterbaking] post-cure for the complete cross-linking of the matrix) which, primarily for reasons of cost, is not necessarily carried out in the autoclave, in the case of fiber composite structures with QuickPacks® embedded according to the above-described process. Accordingly, this tempering process can be carried out only by

the application of unidirectional pressure and heat. For the carbon-fiber-reinforced plastic system (T800/5245C) used here, a tempering process of 4 h @ 210°C is provided. However, in order to avoid stressing the actuators above the temperature level existing in the autoclave, the temperature of the tempering process was lowered to this temperature (180°C), so that the duration for complete [after-cross-linkage] post-cure-cross-linking simultaneously had to be significantly increased. By means of the ILS -values (interlaminar [shearing] shear strength, compare EN 2563) of a number of samples, the modified [tempering] post-cure cycle for the carbon-fiber-reinforced plastic system used here was determined to be 16h @ 180_C, a pressure of 7 - 10 bar being applied in a hot press. Here, different forms of the (mechanical) application of pressure are definitely also conceivable, which do not require high mechanical expenditures. In order to ensure a uniform application of pressure to the actuators, a rubber layer of a thickness of between 15 to 20 mm was found to be suitable which is kept away from a direct contact with the component by several layers of a dense Teflon [woven.] film. The danger of mechanical depolarization of the actuators or of transverse pressure failure of the fiber composite does not exist at these pressures.

VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE CLAIMS

Please amend the Claims as follows:

1. (Amended) A fiber composite structure having laminate layers, with a piezoelectric actuator or sensor integrated therein, wherein:

electric feed lines for the actuator or sensor comprise electrically insulated thin wires;

said wires exit the fiber composite almost perpendicularly to the laminate layers, whereby fibers of the fiber composite structure are not severed by exiting of the feed lines, but are rather slightly pushed apart.

7. (Amended) The fiber composite according to Claim 1, wherein insulation of contact points between the actuator or sensor and the electric feed lines is provided by one of an epoxy resin, an insulating varnish [and] or an insulating polyimide foil.

10. (Amended) A process for producing a fiber composite with an actuator or sensor integrated therein, according to Claim 1, by means of a prepreg or wet-laminating technique and a subsequent [baking] curing at a raised temperature and an increased pressure.

11. (Amended) A process for producing a fiber composite with an actuator or sensor integrated therein according to Claim 1, comprising:

preparing a prepreg or wet-laminar component;

baking the prepreg or [wet-laminar] wet-laminate component at [a raised] an elevated temperature;

tempering the prepreg or wet-laminar component at a raised temperature and an increased pressure.

12. (Amended) The process according to Claim 10, wherein:

openings are present in the pressure [pieces] plates for the pressure treatment of the fiber composite, which openings are used for the guiding-through of feed lines for the actuator or sensor; and

the openings are arranged at the points at which the feed lines for the actuator or sensor emerge from the fiber composite.

14. (Amended) The process according to Claim 12, wherein:

the openings are sealed off by means of a sealing tape; and

because of a pressure difference during the [baking] curing cycle, a portion of the sealing tape is pressed into a gap between the feed line and the pressure piece.

15. (Amended) The process according to Claim 12, wherein pressure [pieces] plates are used which have a reduced stiffness relative to the known pressure [pieces;] plates; and

a thickness of pressure [pieces] plates is less than 5 mm.

16. (Amended) The process according to Claim 15, wherein the thickness of the pressure [pieces] plates is 2 mm.

17. (Amended) The process according to Claim 12, wherein in an area of the actuator or sensor, the pressure [piece] plate has a shallow recess, in a range of from 0.1 to 0.2 mm to prevent a pressing-out of the matrix because of the thickening in this area.